POWER PRESSES

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1.0 SCOPE

The following recommendations provide guidance on mitigation of cracking in power presses. Power presses may be either mechanically or hydraulically driven. Common power press operations are forming, extruding, punching, stretching, stamping or compacting of various materials (metal, paper pulp, wood, plastic, ceramic, etc.).

For guidance on fire hazards associated with hydraulic power presses, please reference Data Sheet 7-98, *Hydraulic Fluids*.

Printing and high pressure forming presses are not addressed in this data sheet. Refer to Data Sheets 7-96, *Printing Plants*, and 12-2, *Vessels and Piping*, respectively.

1.1 Changes

July 2020. Interim revision. Updated contingency planning and sparing guidance.

2.0 LOSS PREVENTION RECOMMENDATIONS

The following recommendations are all intended to mitigate the hazard of cracking. Each recommendation will need to be evaluated for applicability to each individual power press application. Cracking cannot be prevented; however, the following recommendations can help ensure a reasonable press operating period before cracking occurs and provide early detection of cracking so corrective action may be taken prior to catastrophic failure of a press.

2.1 Occupancy

2.1.1 Keep the press and the surrounding area sufficiently clean and well-lighted to permit visual operating inspection of the press.

Visual operating inspection can reveal developing adverse conditions from a loose tie rod to a crack developing in the frame. Poor housekeeping or lighting may mask adverse conditions, delaying identification and reducing the opportunity for corrective action prior to failure.

2.2 Equipment and Processes

2.2.1 Mitigate cracking potential when purchasing a new press by specifying that press parts be constructed of materials that are less likely to crack and that can be weld repaired when cracking is discovered.

Review of cracking incidents has demonstrated cast iron (gray and ductile) press parts are more likely to crack and cannot be weld repaired, although there has been limited success with cold mechanical repair as a temporary solution. When castings cannot be avoided, steel is a better material choice as weld repair may be possible. Forged steel, laminated steel, and welded steel parts are more resistant to cracking than cast parts and are most likely to be weld repairable. With a greater resistance to cracking, forged steel or weld fabricated steel press parts provide the greatest opportunity for detecting cracks before failure occurs.

2.2.2 Provide stress monitoring and protective interlocks on press frame elements and tie rods.

Review of cracking incidents indicates monitoring and interlocks can alert operators to unintended loading of press parts and may be used to stop a press operation as the loading occurs. While such devices cannot prevent unintended loading, they do provide notice of such an event, and interlocks may mitigate the individual event.

2.3 Operation and Maintenance

2.3.1 Operate the press within the parameters specified by the manufacturer.

A press is designed and constructed to perform particular operations for some number of cycles. Operating outside the design parameters can dramatically reduce the service life of the press. If it is desired to modify the application of a press, consult the manufacturer of the press or a knowledgeable press expert to ensure the press can perform the new application for the desired number of cycles.

2.3.2 Establish and implement a press inspection, testing, and maintenance program. See Data Sheet 9-0, *Asset Integrity*, for guidance on developing an asset integrity program.

Examination of a press on the press manufacturer's recommended schedule, a predictive-based (or more advanced type of program), or a preventive program (time-based) schedule provides opportunity to detect cracking and permits either repair or replacement prior to failure. The scope of inspection is not intended to exceed parts of the press that can be readily examined with no more than removal of access cover plates, dust covers, inspection covers, and the like. This in not intended to be a ″dismantle″ inspection.

2.3.3 Establish and implement a press operating controls and protective devices calibration and functional test program.

Properly calibrated and function tested operating controls help prevent unintended press loading. Proper calibration and function testing of protective devices help ensure automatic response to an unintended press loading.

2.3.4 Establish and implement a practice of inspecting the press each time an unintended loading has occurred and each time a press protective device indicates an unintended loading has occurred or the press has stopped due to an unintended loading.

2.3.5 Prior to modifying the operationally stressed parts of a press in any fashion (e.g., drill, grind, cut, weld, etc.) obtain guidance from the press manufacturer or knowledgeable materials person.

Modification of highly stressed press parts can create stress risers. Loss experience demonstrates cracking frequently originates at this sort of stress riser.

2.4 Training

2.4.1 Establish and implement a press operator training program. See Data Sheet 10-8, *Operators.*

Operators are the first line of defense for mitigation of press cracking. Properly trained operators can recognize and appropriately respond to abnormal press operation, including immediate stop of press.

2.5 Contingency Planning

2.5.1 Equipment Contingency Planning

When a press breakdown would result in an unplanned outage to site processes and systems considered key to the continuity of operations, develop and maintain a documented, viable press equipment contingency plan per Data Sheet 9-0, *Asset Integrity*. See Appendix C of that data sheet for guidance on the process of developing and maintaining a viable equipment contingency plan. Also refer to sparing, rental, and redundant equipment mitigation strategy guidance in that data sheet.

In addition, include the following elements in the contingency planning process specific to presses:

A. Press design/construction information.

B. Press component repair/replacement options/sources/strategy and repair history.

C. Press dismantle/re-assembly considerations.

2.5.2 Sparing

Sparing can be a mitigation strategy to reduce the downtime caused by a press breakdown depending on the type, compatibility, availability, fitness for the intended service, and viability of the sparing. For general sparing guidance, see Data Sheet 9-0, *Asset Integrity*.

3.0 SUPPORT FOR RECOMMENDATIONS

Power presses may be either mechanical or hydraulic. Mechanical presses are more common in higher-volume stamping applications common in sheet metal working industries. Hydraulic presses are more common in lower-volume forging (steel and high-strength metals) and extrusion (primarily aluminum) applications. Hydraulic presses are also used in ″board″ manufacturing (plywood, fiberboard, chipboard). Plastic extrusion or injection molding may be done in either hydraulic or mechanical presses.

3.1 FM Power Press Experience

3.1.1 Experience has demonstrated the value of both good housekeeping and good lighting for presses. Visual inspection by operators during operation is key to discovering damage indicators. Along with deterring close examination, oil and grime conceal many visual indicators. Combine poor housekeeping with poor lighting and much opportunity for operators to identify incipient cracking indicators is lost. Lighting and clean press surfaces are also essential for periodic visual inspections by press maintenance personnel.

3.1.2 Review of press cracking incidents reported to FM indicates cast iron parts cannot be successfully weld repaired. It is sometimes possible to effect a temporary cold mechanical repair of cast iron. Cast iron has very little ductility. While it is a very good material for compression and can be reasonably good in tension, it does not respond well to either impact or bending. If a cast press part is unavoidable, steel is a better choice as it has much better ductility and potential for weld repair. The superior materials for press parts, for impact resistance, fatigue life, and potential for repair are forged steel and welded plate steel.

3.1.3 Great improvements have been made in the past 20 years in monitoring press performance, particularly in monitoring the dies of stamping presses. While it is not practical and sometimes not meaningful to monitor press dies (e.g., forging press), it is now economically possible to monitor the major press components for stress and also for vibration. These monitors can be used to keep track of press cycles, press loads, provide an alarm for an overload, and may be interlocked to stop a press upon sensing some predetermined overload. While a monitoring system can mitigate overloading that is the typical cause of press cracking, it cannot prevent overloading. When monitoring and interlocking systems can be economically justified (cost of system versus potential cost savings by mitigating press damage), they should be provided.

3.1.4 A press may be designed for general application or be very specifically designed to meet particular application requirements. In either case, the press manufacturer typically provides a description of operating parameters intended to optimize the productive life of the press. Observance of these parameters can help ensure cracking does not occur prior to a press achieving the number of designed operating cycles.

3.1.5. A press manufacturer typically provides guidance on press inspection and maintenance considered necessary for optimum production of the press. Guidance generally is some combination of time-based and operating cycles-based recommended actions. In some cases, actions are recommended based on observed performance of the press. All press manufacturers can provide inspection and maintenance guidance for specific press designs performing particular operations. Implementing the manufacturer’s guidance can best ensure cracking of press parts is detected in the incipient stage, permitting repair or part replacement before failure occurs.

3.1.6 Presses are equipped with various monitoring and protective devices to inform the operator of press performance and may be used to alert the operator or to stop the press. To obtain the full benefit of these devices, and thus ensure press operation is least likely to be interrupted by cracking, the monitoring equipment needs to be calibrated and functionally tested at intervals selected to ensure the devices will perform as intended.

3.1.7 Unintended overloading of a press cannot be avoided. Overloading might result from double-blanking, mismatch between strength of material and material thickness, off-center loading, etc. A press needs to be carefully inspected following any unintended loading event to assess possible damage. The scope of such examination needs to be considered in relation to the magnitude of the event.

3.1.8 Press operator training can help ensure unintended loading events do not occur and can enable a press operator not only to recognize improper operation of a press but to also take appropriate action to mitigate damage.

3.1.9 Understanding that at some time any press will crack, it is essential to have plans not only for prompt repair of cracks but also to minimize impact on production while a press in being repaired. It is rarely practical to maintain major replacement parts for a press, and some press parts require over a year to manufacture. A good contingency plan for repair might involve a temporary repair to permit continued operation at some level while a replacement part is being manufactured. This plan might also address alternate press capacity in other facilities to ensure minimum impact on meeting contracted deliveries. When evaluating alternative press capacity, it is important to determine whether the alternative press can perform the needed production, has the open time needed, and, when required by the production contract, can be certified for the process.

3.2 Contingency Planning

As part of the ECP, repair services and parts sources need to be verified as being viable. It is not uncommon to find that a supplier no longer has the capability and is no longer a viable option to provide repair services as part on the ECP.

4.0 REFERENCES

4.1 FM

Data Sheet 9-0, *Asset Integrity*
Data Sheet 10-8, *Operators*
Data Sheet 13-1, *Cold Mechanical Repairs*
Data Sheet 13-7, *Gears*
Data Sheet 13-18, *Industrial Clutches and Couplings*

APPENDIX A GLOSSARY OF TERMS

Accumulator: A device that acts upon hydraulic fluid in a vessel, discharging it rapidly to give high hydraulic power, after which the fluid is returned to the vessel by use of low hydraulic power.

Bed area: Cross sectional area of available work space at press base between columns, side plates, back plates, etc.

Bolster: Steel block to which die shoe is attached.

Column: See tie rod.

Container: A device used to hold extrusion die elements.

Conversion Factor: 1 ton = 8.8964 kN.

Crosshead: A fixed block/plate or a block/plate sliding between or along guides (or tie rods) used to support press components and tooling.

Crown: The uppermost fixed portion of a power press. Also referred to as the upper crosshead or platen.

Die cushion: A device located in or under a die block or bolster to provide additional pressure or motion for forming.

Die shoe: A plate or block on which the die elements are mounted. It functions primarily as a base for the complete die assembly and, if used, is attached to the bolster or face of the slide

Energy restricted: Deformation (forging) proceeds until the total kinetic energy is dissipated by the plastic deformation of the material and by the elastic deformation of the ram and anvil when the die faces come into contact.

FM Approved: The term ″FM Approved″ is used to describe a product or service that has satisfied the criteria for Approval by FM Approvals. Refer to the Approval Guide for a complete list of products and services that are FM Approved.

Gib: Removable plate designed to hold other parts in place or act as a bearing, guide or wear surface. Gibs are usually adjustable.

Knuckle: A pivot joint (hinge) between a knuckle link and a connector used to combine the motions of an eccentric to drive a press slide.

NDE: Nondestructive examination.

Platen: A flat plate on which something rests or is pressed. The platen may be fixed or moveable. The term is used interchangeably with crosshead, crown, slide, or bedplate.

Ram: The moving portion of a hydraulic cylinder assembly used for exerting pressure.

Stop: A mechanical device used to prevent movement beyond a set point.

Tie rod: A structural support connecting and aligning press elements. Normally under tension during pressing operations. It is also used as a guide member for the moving element. The term tie rod is often used

interchangeably with the term column. However, in some designs the column acts as a tie rod and in other designs the tie rod is installed inside of a hollow column.

APPENDIX B DOCUMENT REVISION HISTORY

The purpose of this appendix is to capture the changes that were made to this document each time it was published. Please note that section numbers refer specifically to those in the version published on the date shown (i.e., the section numbers are not always the same from version to version).

July 2020. Interim revision. Updated contingency planning and sparing guidance.

April 2011. This data sheet has been completely rewritten.

May 2003. Minor editorial changes were made for this revision.

January 2000. This revision of the document was reorganized to provide a consistent format.

March 1991. All power press data united in this single-source data sheet and revision of recommendations.